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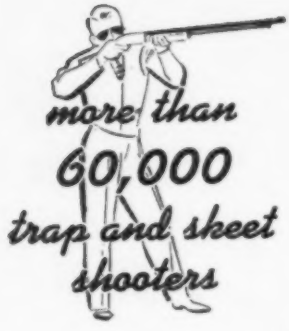

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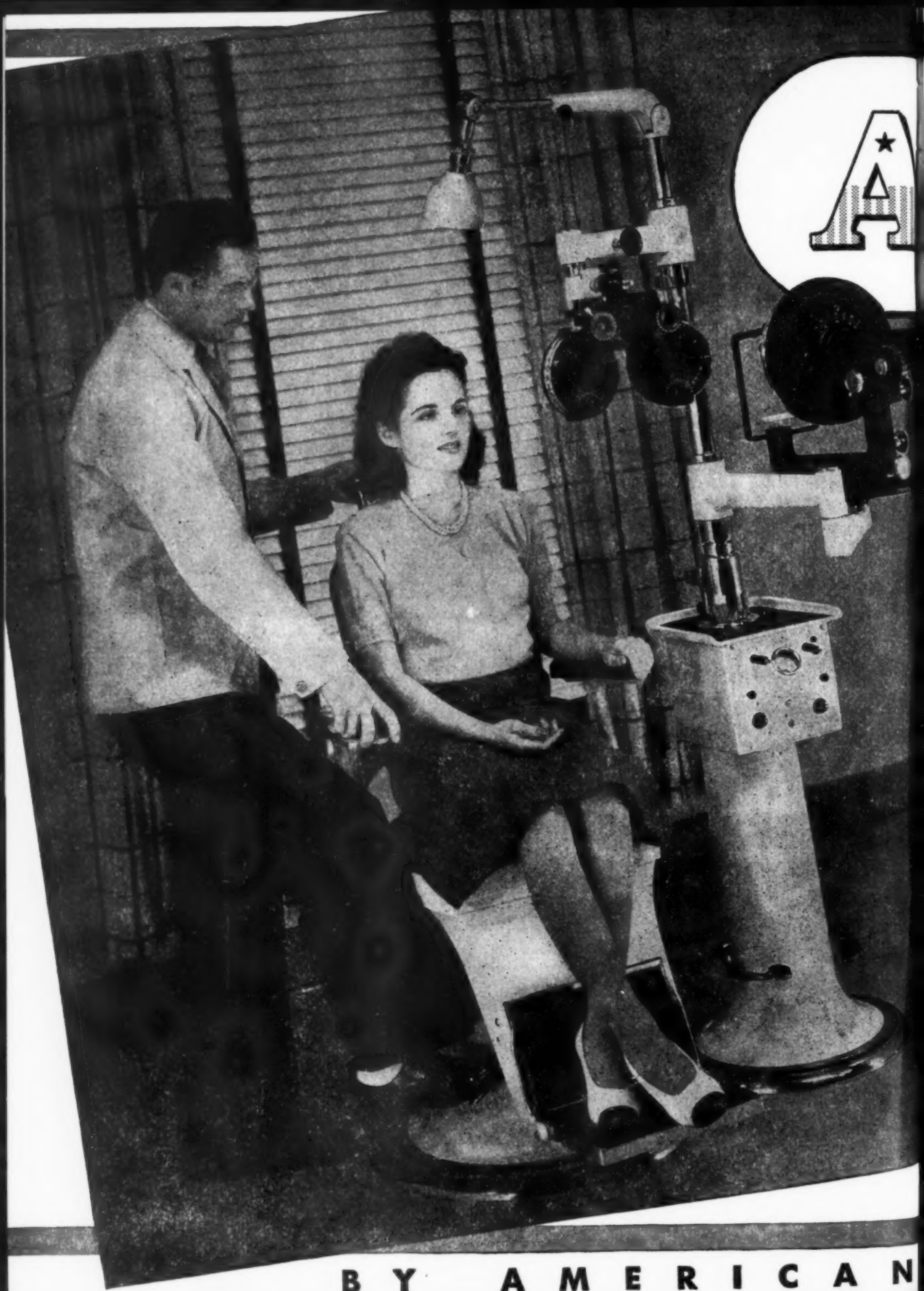
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AMERICAN JOURNAL OF OPTOMETRY
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Vol. 18 MAY, 1941 No. 5

STUDIES IN THE CONTROL OF AMBLYOPIA*

R. M. Hall, Opt.D., F.A.A.O.
Cleveland, Ohio

It is a common experience in the refraction of amblyopic subjects that the corrective lens found by skiascopy is often not the lens giving maximum acuity as determined by a subjective examination. Furthermore, the subjective prescription itself may not give a complete indication of visual efficiency since there may be marked differences in retinal sensibility among subjects with the same visual acuity.[1] While these differences may not be considered important factors in subjects with normal acuity, a similar conclusion with respect to low-vision subjects is not warranted on the same premise. Furthermore, it should not be assumed that gross test-objects of the order of the 20/200 E are sufficiently sensitive for determining small refractive errors.

It would seem that the appraisal of the visual efficiency of all subjects should be modified in such a way as to include all primarily important functions of seeing—particularly in cases of sub-normal vision or amblyopia. In a previous paper,[2] the author suggested one such modification, and discussed the advantages of using photometric criteria in appraising visual efficiency. This method involved a test-object of constant size, the visibility of which was measured by the Luckiesh-Moss Visibility Meter. Thus visual changes were noted in terms of relative visibility (involving brightness-contrast thresholds) rather than in terms of the Snellen fraction (involving resolution thresholds). It was shown that this method not only eliminated the deleterious factor of learning, but also that the progress made in the treatment of cases of sub-normal vision could be determined with greater certainty.

As a parallel procedure for maintaining better control of binocularity during orthoptic training periods, the use of neutral filters in

*An abridgment of the material presented before the American Academy of Optometry. For publication in the May, 1941, issue of the AMERICAN JOURNAL OF OPTOMETRY AND ARCHIVES OF AMERICAN ACADEMY OF OPTOMETRY.

conjunction with orthoptic apparatus was also suggested.[8] In this procedure, the vision of the better eye is gradually reduced to equal that of the poorer by interposing a gradient filter before the better eye. This nicety of visual control, together with the control of light intensity, target size, and the amount of prismatic power, served to stimulate sensitivity of the amblyopic eye and to produce conditions more desirable for the binocular act.

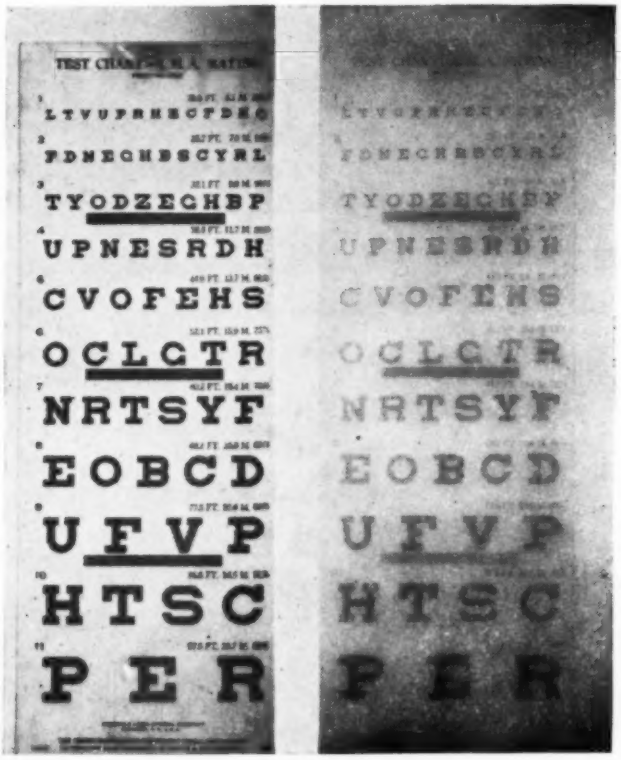

Figure 1. Standard A. M. A. chart photographed through (1) plano lens fully polished, (2) plano lens half polished, a 40% difference in Relative Visibility.

Experience has shown that the wearing of ophthalmic corrections, presumed to be appropriate, and supplemented by occasional orthoptic exercises is not always sufficient to result in a substantial reduction in amblyopia. In view of this fact, it is conceivable that a continuously applied means for obtaining balanced binocular visibility might be more effective. Actually several methods have been devised and employed whereby the anomalous eye would be "forced to work." These procedures include (1) the total occlusion of the habitually fixing eye by means of bandages, opaque occluders, or strong convex lenses; (2) par-

tial occlusion by the use of atropine, slight over-correction of plus lens power, Chavaise glass, or a lacquer film applied to the lens surface.[4]

It may be stated from experience that none of the methods mentioned have proven entirely satisfactory, either from the therapeutic results obtained, or from the standpoint of eliciting full cooperation of the patient. For example, in many cases where the vision of the amblyopic eye is of the order of 20/80 or less, total occlusion for an hour or two a day, or constantly over a period of weeks, usually results in but little improvement, and often arouses antagonism on the part of young patients; and partial occlusion, even when accompanied by orthoptic exercises, may not produce lasting beneficial effects. In subjects where the vision of the amblyopic eye is 20/80 or better, total occlusion for short periods, or partial occlusion for longer periods, will usually result in an increase in visual acuity, as would be expected. However, a decrease in visual acuity may result when the training is discontinued.

Although these methods have been used to advantage in specific cases, each involves certain inherent factors which tend to reduce the effectiveness of the procedures. Thus in total occlusion the normal association between accommodation and convergence is disturbed and there remains no possibility for binocular integration. Eventually this may result in a suppression of the normally fixing eye. The use of atropine, while of some value in differentiating and reducing accommodative squints, may serve to aggravate the amblyopia due to its effect upon the binocular act. It also appears that slight over-correction with convex-lens power not only distorts the relation between accommodation and convergence, but also may cause a disparity of the retinal images. These effects may negatively influence amblyopia.[5]

For several years the author and others have been experimenting with diffusion lenses, varying the amount of diffusion over the fixing eye so that approximately equal vision is obtained by the two eyes. The procedure used is as follows:

(1) After the approximate refraction has been determined with the skiascope, the lens power is decreased or increased in order to obtain *maximal* visibility as indicated by the Luckiesh-Moss Sensitometer.

(2) The relative visibilities of the two eyes are then compared, and lenses of varied diffuseness are successively placed before the better eye until a degree of diffusion is found which will approximately equalize the visibility of the fixing eye and that of its amblyopic fellow.

(3) The final prescription is then ordered, giving the original prescription, but with a diffusing surface left on the lens to be used before the non-amblyopic eye. Any degree of diffusion (see Figure 1) can be obtained through incomplete polishing of the lens. However, it is to be emphasized that an identical effect cannot be obtained if the lens is first brought up to a full polish and then re-'fined.' In the latter procedure, the lens becomes frosted and translucent.

As vision in the amblyopic eye improves (as noted by sensitometric measurements) visibility may be kept constantly in balance by increasing the polish of the diffused surface of the ophthalmic lens.

In summary, the present method involves (1) an unusually precise method of measuring visual efficiency, (2) a means of accurately determining the lens power giving maximum visibility, (3) a constant control of the binocular balance during orthoptic training periods in the clinic as well as under ordinary seeing conditions, and (4) the achievement of these objectives with a minimum disturbance of the accommodation-convergence relationship, and little or no change in image size.

DR. R. M. HALL
419 GUARDIAN BUILDING
CLEVELAND, OHIO

DISCUSSION

DR. VAN SHUYTERS: How do you determine from the amount of polishing whether the visual acuity will be reduced to the point you want?

DR. HALL: We have a series of six standard lenses varying in diffusion from 2% to 75%. The test lens selected is sent to the surfacer along with the prescription, and he is asked to match the surfaces as near as possible. At present, it is of necessity a trial and error method, yet it is surprising to find how close an experienced surface man can match the polish.

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ORTHOPTIC CASE REPORT*

William Smith, Opt. D., F.A.A.O.
Roxbury, Mass.

The efficacy of orthoptic treatment as a re-educative procedure for the correction of strabismus, has been demonstrated on numerous occasions by this writer and others in periodic case reports. The following case tends to prove further the value of orthoptics, not as an adjunct to other forms of treatment, but as a specific and dependable mode of therapy.

There is no denying, that in some instances, combined treatment of surgery and orthoptics is most effective. In such cases, however, experience indicates that the best results are obtained, by both preceding the operation and following it, with orthoptics. During the first part of such a routine, visual orientation, suppression, projection, macular fixation, attention and visual acuity are to be treated and trained. The post-operative phase is to deal entirely with the development of the binocular co-ordination function.

Case report: Miss B. J. C., age 18, a student, was referred to the orthoptic clinic the early part of January, 1940. At the time, she had left hyper-esotropia complicated with amblyopia-ex-anopsia. The muscular abnormalities, according to the patient, have been prevalent since early childhood. An operation was performed about 12 years ago at the eye clinic of a hospital in Baltimore and the anomaly partly reduced. Miss C. was to have returned for a second operation, but her family was obliged to change residence and no further surgical treatment was attempted.

The patient's general health had been excellent. Whatever abnormality existed, was confined to the left eye. Miss C. was left-handed and during her early schooling an attempt was made to change the

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handedness, but this was soon abandoned. She had had measles and the mumps, but didn't recall having any other ailments.

A preliminary orthoptic routine examination was made during which the following data were obtained: Visual acuity with and without correction: O.D. 20/20; O.S. 20/200+. Pinhole vision O.S. 20/100. Near vision O.S. J. 20 type with difficulty. The objective angles of deviation on the perimeter were: 15° Left Esotropia and 8° Left Hypertropia. There also was marked left suppression. Fixation and projection were faulty. On repeated tests, anomalous retinal correspondence was indicated. The apparatus used was the Hering After-Image Test. Fusion was absent (both near and distant), although there was intermittent binocular perception—not simultaneous. The ocular versions and rotations were smooth and extensive. The patient was wearing:

O.D. +1.25D. Sph. ⊂ +0.25 D. Cyl. Axis 90
O.S. +1.50D. Sph.

The fundi, pupillary reactions to light and accommodation, the media and the external eye were normal. The accommodative amplitude in the right eye by the push-up test measured 12 diopters. In the left eye this was undeterminable.

Since early childhood, the patient had been obsessed with the desire to become an aviatrix. To attain that end, she had been taking flying lessons since she was seventeen. She was ready for her solo flight in 1939, but because of the existing ocular condition, she failed in that part of the physical test. It was with the hope of eventually developing sight in the left eye and learning binocular co-ordination that she started orthoptic training. In keeping with our procedure, an orthoptic training program was prepared and outlined. The steps were based on the findings derived from the preliminary refraction and orthoptic routine examinations.

OUTLINE OF ORTHOPTIC TRAINING PROGRAM

(A) *Visual development training*
1. Near and distance visual acuity training.
2. Retinal stimulation.
3. Macular fixation and projection training.
4. Visual orientation, tracing and monocular cheiroscopic training.
5. Supplementary treatment.

(B) *Co-ordination training*
1. Monocular, binocular and simultaneous binocular fixation training, to diplopia.
2. Ocular version and rotation training, with emphasis on the vertical muscles.

3. Fusion training to orthophoria (zero position on the cards) with the hope of establishing normal retinal correspondence, by re-establishing macular fixation.
4. Duction training.
5. Amplitude of fusion training.
6. Stereopsis training.

(C) *Home training*

1. Total occlusion of right eye for long periods at a time.
2. Near point reading—books, magazines, papers.
3. Distance vision training on Snellen charts which were provided.
4. Macular fixation and projection training by tracing and on the projection training plates devised by this writer.

The patient was instructed to keep a record of all homework and to bring in all tracing papers, reading material and a time record at stated intervals. She was also instructed to occlude the right eye when viewing motion pictures and to watch the pictures with the left. The patient procured a black celluloid eye-patch which she constantly carried with her and made use of at every opportune time. All home exercises were to be done on the days that she did not come to the clinic. The orthoptic clinic was open one morning and two afternoons each week during the school term and three mornings during the summer vacation period.

In the visual development part of the treatment, Snellen, Keystone and specially improvised cards were used for distant visual acuity training. Books of varying size type were used for near point visual training. For retinal stimulation a wired tin-drum with a 15-watt bulb was used. The drum was placed in front of the tele-binocular and a one-second interval flasher was used for flashing. Some time later a new flashing device was made, consisting of a large chromium-plated funnel placed in front of a goose neck lamp having a 100-watt frosted bulb. A one-second interval flasher was also used with this device.

Keystone stereopsis cards were used in training visual orientation. The object of this treatment is to establish mental perception of composite scenes as well as of individual objects in the amblyopic eye. In strabismus with high amblyopia this function is often entirely undeveloped. We have added a motion picture projector to our orthoptic equipment and are using it for training visual orientation, visual acuity and fusion amplitude.

Tracing was done on a frosted glass-top tracing box, fitted with six 25-watt frosted bulbs, all working on a single flasher. Pictures for tracing were drawn on architect's drawing cloth and tracing paper used. The patient was instructed to trace only when the lights were on. Work

was done with the better eye occluded and occasionally no correction was worn during this and some of the other exercises. For cheiroscopic training the correct-eye-scope was used. Only the left eye was treated, the right was occluded. The Pine, and other specially improvised cards were used for this training. For projection training cards devised by the writer were used. These cards consist of simple pictures drawn on cardboard with holes punched in different parts of the cards. The patient is required to put colored toothpicks into these holes, the better eye being occluded.

The Keystone tele-eye-trainer and cards were used in the co-ordination part of the treatment procedure. Horizontal and vertical calisthenics were given with the No. 2 rotor and the calisthenic cards. Monocular and binocular fixation training were given with the No. 3 rotor and the split cards having dissimilar objects, such as Bird and Cage. Ocular versions and rotational exercises were given with the Arneson Squint Korrector. Prisms with bases In, Up and Down (frequently the latter only) were used. The remainder of the binocular co-ordination phase was carried out on the Keystone apparatus. All measurements were made on the American Optical Company, Wells Head Phoropter. This was done for the sake of consistency, and was carried out all through the training procedure. It is part of our procedure to do all distant visual acuity measurements with Snellen and those for the near point, with Jaegar type cards. This insures consistency of measurement and makes recording easier.

The patient remained at the clinic from the early part of January, 1940, until the middle of June of the same year. During this period only the visual development part of the training program was given her. When she left the clinic, the distant visual acuity was recorded as 20/100+, with and without correction, and at near, J.12 type. She had developed fairly good fixation and projection. The angles of deviation remained unchanged and she still had anomalous retinal correspondence. Color and form fields appeared normal and she had good color perception, when tested on the standard color tests.

Two reasons impelled the patient to leave the clinic and to become the writer's private patient. In June, sickness made it necessary for me to leave the clinic for the remainder of the summer, and inasmuch as this patient wanted to continue under our personal care, she obtained permission to change. Besides, she had applied for admission into an out-of-town college and was anxious to complete treatments by the time school started. She resumed treatments on July first, at which time an orthoptic

re-check was made. No change was observed from the findings recorded at the time she left the clinic.

The training program originally outlined was continued. Her visits were changed to daily treatment periods, and each visit was to be of long duration. Furthermore, the home training exercises were increased and more carefully supervised.

On July 10, the patient had 20/60+ Snellen visual acuity in the left eye. She also read several letters on the 50-foot line and a single one on the 40-foot line; this with much effort. At near she read J. 12 and some letters on the J. 10 line, with and without correction.

On July 24, the patient's visual acuity in the left eye was increased to 20/40 on the Snellen chart and to 20/30 on the Keystone V.A. 2 cards. At this time, too, she was able to read some of the letters on the Keystone stereometric cards. Five minute retinal stimulations were given on the chromium plated reflecting funnel and the 100 watt bulb.

On July 26, a test for retinal correspondence was repeated and found to be unchanged. The training program was increased at this time to include muscular calisthenics. The Keystone tele-eye-trainer and the Keystone left hyperphoria calisthenic cards were used in addition to the American Optical Company, Wells Phoropter and Wells B.1, B.2 and B.3 cards and the Arneson Squint Korrector. Base-In calisthenics were given on the instruments mentioned with appropriate cards and combined prisms when indicated. The time limit for these calisthenics varied from 10 to 30 minutes. Visual acuity and macular development training were continued as before.

On August 7 a new refractive examination was made and the following prescription ordered:

O.D. +0.75 D.Sph. ⊃+0.50 D.Cyl. Axis 90=V.A. 20/20
O.S. +0.75 D.Sph. ⊃+0.25 D.Cyl. Axis 90=V.A. 20/40+2

At this time also, the patient reported of having constant diplopia.

The manifestation of diplopia was an indication that the patient was ready for the second phase of the training procedure. Coordination training, consisting of the following steps was then added: (1) Monocular, binocular and simultaneous binocular fixation training to intensify macular fixation and perception. (2) Superimposition training as a preliminary to fusion training. (3) Fusion training, using simple fusion cards and ocular calisthenics together with fusion. The fixation targets were

changed frequently. At times the targets were fixed and at other times they were rotating. The position of the prism bases were In, Up and Down, alternatingly. These calisthenics were made a daily routine. The objective was to reduce the vertical and horizontal muscular defects. On August 29, 1940, the patient's distant visual acuity was tested at the airport and was found to be: O.D. 20/20; O.S. 20/40+3.

On September 9, 1940, a test revealed 2△ of left hyperphoria. A single prism, 15D, Base-In, was used in testing. She also had exophoria, at distant and near tonicity tests. At this time the training program was increased by the addition of fusion and duction amplitude training. On September 18, 1940, the visual acuity of the left eye was 20/30, with and without correction. The patient was able to fuse objects on the Keystone and Wells fusion cards; and she could maintain it to a point of 15D. Base-In between both eyes, without effort. Glasses were at this time completely eliminated during treatments. However, the patient was instructed to use them at other times, especially for near work.

On October 29, 1940, the horizontal ductions were measured without correction, showing the following: Adduction 14D.; Abduction 6D. On November 16, 1940, the patient had good fusion amplitude. She was able to maintain it on the tele-binocular from orthophoria to 15D. Base-In. This was checked on the Wells-head Phoropter. She was started on stereopsis training and development. From this point on until December 10, 1940, visual acuity and binocular co-ordination phases of the training program were carried out and intensified. Duction amplitudes were developed and vertical calisthenics were kept up persistently. On December 10th, the patient was successful in passing the physical and eye examination tests at the airport and on December 24, made her solo flight and was granted a pilot's license.

Although the patient had accomplished her primary objective, she is still continuing orthoptic training. Vision and co-ordination functions are still given and checked repeatedly. Using the Keystone Progress Fusion cards, PF 15 (100 per cent fusion) she can fuse the four balls into three, during near and distant fusion measurement tests. The same is demonstrated on other instruments, yet, in spite of these confirmations of bifoveal fixation and fusion, anomalous retinal correspondence by the after image test, persists.

OBSERVATIONS AND CONCLUSIONS

The outcome of this case and the observations made in the course of training have led to some very interesting conclusions: (1) That the

development of binocular coordination is proportionately dependent upon, and influenced by, the amount of visual acuity developed. (2) That the elimination of macular suppression and the re-establishment of a path of conduction from the retina to the visual centers in the cortex is of utmost importance. (3) That the treatment periods must be of sufficient duration and frequency to insure maximum results. This became evident when this patient was put on lengthy treatments daily, instead of the three weekly treatments of fifteen or twenty minutes each, as at the clinic. (4) That all home treatment is valueless, unless rigidly supervised. (5) That co-operation on the part of the patient is in a large measure responsible for the outcome. (6) That a definite and prearranged treatment program based on the preliminary routine tests is absolutely necessary. (7) That careful checking and cross-checking on several types of apparatus, is invaluable. (8) That the reliability of retinal correspondence as a prognostic test in strabismus becomes rather questionable. We have observed this in several cases. In some of these, repeated tests showed anomalous retinal correspondence at the beginning as well as at the conclusion of the treatment despite the indication of bifoveal fixation, good fusion amplitude and stereopsis. In at least three cases, anomalous retinal correspondence shown at the beginning of the training, became normal toward the conclusion.

The observations regarding retinal correspondence indicate the serious need for clinical study of this phenomenon as it pertains to strabismus. Because of the lack of definite prognostic tests, it is the policy of our clinic to accept for orthoptic training all types of cases of muscular abnormalities, excepting paralytic squints and those with ocular pathology. The reason for such a policy is the hope for an eventual development of such prognostic tests.

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THE REFRACTION PROCEDURE IN THE FITTING OF CONTACT LENSES*

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The earliest contact lenses consisted entirely of glass, and were conceived as an optical medium for the correction of irregular corneal surfaces. In applying contact lenses to this use, it was found that the lens filled with water and placed over the cornea served to neutralize irregularities, optically speaking, and thus removed the visual distortion resulting from the irregularity.

This procedure led to very practical results, since an optically perfect surface could be provided with any one of a series of lenses having a great variety of inside corneal curvatures. For example, irregularities resulting from keratoconus or scarred corneas could be corrected with lenses having inside corneal radii of 7.0, 7.5, 8.0, or 8.5 mm. The exact form of the corneal section of the lens thus became relatively unimportant, except insofar as corneal clearance was concerned. In cases of keratoconus, the protrusion of the apex of the cornea and the consequent increase in corneal sagittal depth made it advisable to use a lens with a short radius in the corneal section, since such a lens provided greater corneal clearance.

The next stage in the development of contact lenses as an optical corrective agent was in the correction of refractive error, particularly high myopia and high hyperopia. In dealing with this problem, it was likewise found possible to use any of a series of inside corneal radii as a base, and then correct whatever refractive error remained by changing the outside corneal radius. The practical result of this finding was the development of lenses with inside corneal radii ranging from 6.0 to 10.0 mm.

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But considering that lenses with each of these various corneal radii had to be available in combinations incorporating a wide variety of scleral radii, it is obvious that an altogether inconvenient, not to say impracticable, number of combinations resulted.

Other difficulties were encountered. When a particular lens was found that did clear the cornea and therefore provided a comfortable fit, purely mechanical factors in the construction of the lens would, in the case of some prescriptions, make it impossible to attain a smooth outside junction between the corneal and scleral sections. This situation was met by substituting a lens with a different inside corneal radius which would permit the outside surface to be ground satisfactorily. But then the change in the inside radius resulted in an uncomfortable fit. It was found also that the inside corneal curve with its attendant junction with the scleral curve was in itself a variable factor affecting the degree of comfort experienced with the lens.

Still another unfavorable factor in regard to the early type of contact lenses was the difficulty encountered in transposing the optical qualities of one inside radius to another. The whole question of the optics of the contact lens was predicated upon the measurement of the patient's cornea with the ophthalmometer, the measurement of the refraction with the trial contact lens, and then the recomputation and transference of this to the new lens with a different inside corneal curvature. This type of optical transference led to certain difficulties because of possible sources of error. For example, a measurement taken with a lens having an inside corneal radius of 8.0 mm. assumed a certain thickness of "water lens" which was necessarily different from that of a lens with a corneal radius of 7.5 mm. Since there was no adequate way of measuring this difference, there was a possibility of error in the finished prescription.

In order to avoid such unknown and variable factors and to minimize the optical difficulties encountered in fitting, a simplification of the entire procedure was developed. Today, all of the Plastic Contact Lenses used for the correction of ordinary refractive errors have an inside corneal radius of 8.5 mm., and the only change made in order to obtain proper refraction in any individual case is to alter the outside corneal radius. In keratoconus or other cases in which a greater sagittal depth is desired, this may be achieved either by increasing the build-up at the junction of the corneal and scleral sections, or by using a corneal section with a shorter (7.5 mm.) inside radius.

The procedure in refracting according to this simplified method involves the following steps:

(1) *Insertion of a trial contact lens.* Any of the trial contact lenses having an inside corneal radius of 8.5 mm. may be used.

(2) *Objective test with retinoscope and subjective test with spheres.* Regular trial frame and trial case spherical lenses are used.

(3) *Determination of the distance between the anterior surface of the contact lens and the trial spectacle lens.* A specially designed millimeter contact lens gauge is used for this purpose.

(4) *Determination of the final prescription.* This is computed at the factory on the basis of data obtained in steps (1), (2), and (3) above when carried out with the proper fitting trial contact lens.

Each of the trial lenses of this type of contact lens already contains a prescription of approximately —3.00 D. This refractive power is placed in the contact lens in order to partially correct the myopia which is present in most cases. It should be emphasized that with the trial contact lens alone one cannot expect to give every patient normal vision. For example, if a patient wears O.U. —7.00 D. S., the trial lens containing —3.00 will correct a certain part of the —7.00, but just how much of it will be corrected cannot be determined beforehand. It is surprising, however, to note the number of cases in which the trial lens alone will provide good vision. The —3.00 prescription in the trial contact lens may, in individual cases, correct myopias ranging from —3.00 to —8.00 D. because of the difference between the curvature of the patient's cornea and the curvature of the inside surface of the corneal section of the lens.

To cite a few examples of such correction: A patient whose ophthalmometer reading is 43 D. and who has a refractive error of —4.00 D.S., may obtain visual acuity of 20/20 with the trial contact lens. Visual acuity of 20/20 may also be achieved with the trial lens alone, in the case of a patient whose ophthalmometer reading is 44.50 D. and whose refractive error is —5.50 D.S., or in the case of one whose ophthalmometer reading is 48 D. and whose refractive error is —8.00 D.S. Such correction is possible, of course, because in each of these three instances the refractive error is due to the curvature of the cornea, and not to any change in the axial length of the eyeball.

After the trial contact lens has been inserted, the residual refractive error is determined by retinoscopy and subjective tests with regular trial

frame and spherical trial case spectacle lenses. Whatever sphere is required in addition to the contact lens to bring the visual acuity to 20/20 is then added to the power of the trial contact lens as the next step in determining the final prescription. The advantages of this procedure over the older method are: (1) The final prescription is independent of any computation involving the corneal radius as obtained with the ophthalmometer. (2) There can be no error because of uncertainty with regard to the distance between the inside surface of the contact lens and the cornea, since this distance in the trial contact lens is faithfully reproduced in the finished prescription lens. (3) The possible number of lens combinations required to correct any refractive error is considerably reduced.

After determination of the subjective prescription required to obtain visual acuity of 20/20, it is necessary to obtain the distance between the outside surface of the glass corneal section of the contact lens and the inside surface of the spectacle lens in the trial frame. This is the last step in the preliminary determination of the final prescription, and it is obtained by measuring this distance with a specially designed contact lens gauge. In using the gauge, the following procedure should be observed: (1) Be sure that the trial frame has been snugly adjusted to the patient before making the subjective tests, so that it will not have shifted its position prior to measurement with the gauge. (2) Insert the narrow end of the gauge gently from the temporal side. If the trial frame does not permit horizontal insertion of the gauge, then insert it either from above or below on the temporal side. (3) Press the arms of the gauge gently together until the two "contact" ends just touch the contact lens and the spectacle lens. Be careful not to exert too much pressure, since by doing so the eyeball may be pushed slightly inward or the spectacle lens slightly outward, thus invalidating the measurement. A little practice will enable the practitioner to recognize the point at which contact is made between the gauge and the lenses. (4) Read the graduated scale on the gauge and record the reading to the nearest millimeter.

When the procedure outlined above has been completed for both eyes, the prescription form should be filled out in the following manner: (1) *Trial case number.* This indicates to the manufacturer the exact refractive power of each of the lenses in the set. (2) *Trial contact lens used.* (26 T, 38 T, 28 T, 36, etc.) (3) *Refractive correction.* As deter-

mined subjectively with trial frame and lenses over the contact lens. (4) *Contact lens gauge reading to the nearest millimeter.*

The preliminary refraction procedure described above is done during the patient's first visit. It serves to indicate to the patient that he gets good vision with contact lenses, and provides the practitioner with data which enable him to arrive at the approximate correction needed in the final prescription. After the proper scleral fit has been determined, it is necessary to repeat the refraction because the lens which gives a proper scleral fit may have a different scleral radius than the trial lens used in the preliminary refraction. This difference may move the corneal section of the lens closer to or further from the cornea, and thus change the correction by as much as one-half of a diopter, or even more in some instances. Therefore, after a comfortable scleral fit has been obtained, a second refraction is performed and the final prescription written.

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THE RELATIONSHIP BETWEEN DISTANCE AND NEAR SCREENING TESTS AMONG SCHOOL CHILDREN*

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Out of the recent interest in school eye testing has come the assertion that no screening test can be adequate unless it includes a test at the reading distance. The teacher is interested only to the extent that the screening test be efficient and that any testing method be kept to the minimum of time consumption consistent with efficiency, so as not to encroach on instruction time and the teaching program. This raises a question which must be answered with scientific proof: Is the additional test at the reading distance really necessary?

To compare the results of the numerous techniques for screening at 20 feet and at the reading distance is beyond the scope of this report, but a comparison of two representative tests is presented to throw some light on the problem.

Two hundred unselected school children were given the conventional Snellen Test for distance vision and a near vision test consisting of a scale of paragraphs graded according to the size of type, which were presented for reading. The smallest size of print which could be read was taken as the measure of the acuity at the reading distance. Assuming, for the purposes of the study, that no real standards existed for either test, the results were distributed and the positions of the modes and medians of each were determined. Three separate groupings were made; one for the right eye, one for the left eye, and one for both eyes. The results in these groups were so closely comparable that only those of the latter are reported in this paper.

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The mode of the distribution of Snellen scores fell in the 20/30 to 20/15 range, while that of the near test occurred between letter sizes ranging from 0.696 to 0.521 millimeters.

The median of the scores of the Snellen Test (hereafter referred to as the distance test) fell in the 20/20 interval, while the median of the near test scores was found in the 0.521 millimeter interval.

The results of the two tests were correlated, by the mean square contingency method, and the result was .68, indicating a marked correspondence between them. Next a sufficient number of cases were given complete eye examinations to permit the establishment of a group of 100 cases with eye trouble sufficient to warrant the use of glasses or some other form of treatment. These were divided into two groups as follows:

Group 1. Conditions in which vision is not likely to be greatly reduced, including hypermetropia, hypermetropic astigmatism, muscular imbalance or fusion deficiency.

Group 2. Conditions in which vision is likely to be reduced, including myopia, myopic astigmatism, amblyopia or ocular disease.

The calculations were repeated for each group and they correlated as follows:

Group 1. .84, a considerably higher correlation than that of the entire group.

Group 2. .10, practically no relationship at all.

A high correlation between the scores of two tests does not mean that they measure the same thing, but it indicates that there is close correspondence between their results. Then failure of either test implies the same thing, in this case the need for professional eye examination, and the test results have a marked correspondence as in the case of Group 1 either may be used for practical purposes. This suggests that either the distance test or the near test may be used alone with reasonably good success in Group 1 but not in Group 2.

A review of the cases disclosed the fact that although there were some which passed the near test and failed the distance test, *none* failed the near test and passed the distance test. Since the results of both tests corresponded reasonably well in Group 1, and in view of the fact that there were *no* cases which failed the near test and passed the distance

test, use of the near test as a supplement to the distance test is probably unnecessary.

Summary: A study of the results of vision tests at 20 feet and at the reading distance in a group of 200 unselected school children revealed relationships which imply that the distance test need not be supplemented by the near vision test.

TABLE

Number of cases in the study		200
a. Central Tendency:		
Median	Distance test, 20/20	
	Near test, 0.521 mm. letters	
b. Correlation* between results of distance test and near test		.68
Sub-groups. Number of cases		100
Correlation between results of distance and near tests:		
Group 1.		.84
Group 2.		.10

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*Perfect correlation is expressed by 1.00.

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THE INDIVIDUAL OPTOMETRIST IN THE FIELD OF BLINDNESS PREVENTION

According to Best,[1] blindness is to be regarded as not of a few degrees, varying all the way from a condition where the want of sight is absolute or total, to a condition where the sense of vision, while impaired so as to be of little actual use, does exist in some slight measure. In other words, Best properly includes among those patients classified under the term "blind," all persons whose corrected visual acuity is below the minimum level of useful seeing, as well as those patients who have no

vision at all. This view is also held by the courts, optometrical and medical societies and governmental agencies who deal with the handicapped.

Naturally, such a mass grouping of those patients with sub-normal vision includes a large number of patients who, by their very weight of numbers presents a challenge to organized optometry. A challenge on two major fronts, (1) remedial, and (2) preventative.

The optometrist, as a specialist in visual problems, must first do everything possible to assist those patients with sub-normal vision. This can, at times, be done by the visual re-educational processes presented so effectively to optometry by Feinbloom[13] and Jaeckle.[12] Here, with the assistance of technical sub-normal visual aids, vision can be restored to useful levels and patients once handicapped, can be given a new start in society.

And next, the challenge to prevent, as far as this is possible, the addition to the ranks of the blind, by those patients who are now suffering from ocular disorders which may prove serious in later months or years, if now neglected. A job of ocular screening in which every optometrist must do his part.

This is a dual problem with many important aspects, all requiring serious attention, Already optometry has made important contributions to the specialized field of improving the visual efficiency of those with sub-normal vision. Hall,[5] Neill,[7, 11] Hurwitz,[9] Tait,[11] Friedman,[15] Jaeckle[6, 14] and Feinbloom,[3] to mention but a few, have done much to advance our knowledge and techniques in the field of sub-normal vision correction.

Much work, too, has been done in the preventive field by optometrists. Needles and Heather,[4] Gasson,[8] DuPlessis[17] and the writer,[10, 16] to again mention but a few, who have made contributions having to do with visual preventive work in optometry. It is towards this activity in particular that our attention is now directed.

Blindness may occur from a number of causes. In classifying these from an etiological standpoint one may group these causes in the following seven major classifications.[18] (1) Congenital and hereditary blindness (other than syphilitic), cataract, malformations and anomalies (albinism, dislocated lens, etc.), optic atrophy, retinitis pigmentosa, etc.; (2) blindness from trauma (including eye infections following injury and sympathetic opthalmia), industrial injuries (including industrial

poisonings and burns), non-industrial injuries (war, fireworks or firearms, play or sport, household activities, street accidents, accidents of surgical operation, etc.); (3) toxic amblyopias (excluding industrial poisoning), amaurosis from tobacco, alcohol (ethyl methyl), etc.; (4) blindness as the result of general infectious diseases—syphilis (congenital, acquired), tuberculosis, cerebrospinal meningitis, measles, typhoid fever, scarlatina, smallpox, diphtheria, pneumonia and influenza, eczema, etc.; (5) blindness due to systemic diseases (excluding infectious diseases)—diabetes, nephritis and other kidney diseases, arteriosclerosis, multiple sclerosis, metabolic imbalance, etc.; (6) blindness due to definite or specific eye diseases such as ophthalmia neonatorum (gonorrhea, etc.), purulent conjunctivitis, etc.; (7) blindness due to chronic or idiopathic definite eye diseases such as glaucoma, diseases of the conjunctiva (trachoma, etc.), diseases of the cornea (keratitis, ulcers, etc.), diseases of the iris and ciliary body (iridocyclitis, iritis, etc.), diseases of the crystalline lens (cataract), diseases of the choroid and retina (detachment of retina, retinal hemorrhage, disseminated chorioretinitis, etc.), atrophic and neuritic diseases (optic neuritis and atrophy, etc.), degenerative changes (retinitis pigmentosa, etc.), tumors (intracranial and extracranial, both malignant and benign), errors of refraction and motor anomalies (progressive myopia, high hyperopia, amblyopia ex anopsia, high degrees of astigmatism, etc.), amblyopia, intraocular hemorrhage, etc.

These classifications, presenting as they do the major causes of blindness, indicate also the scope of work to be done in preventing blindness. If effective preventive work is to be done in this field of activity, as optometrists we must first know just what our problems are, and then also know the numerical order in which these occur.

The data presented in the following tables have been taken and condensed from a statistical study made of the causes of blindness in the United States by the United States Census Bureau.[2] The figures are said,[1] to contain certain inaccuracies due to the method of compiling the data, and also to the character of ocular examination made upon the 40,000 persons whose blindness is reported upon in this report. Despite these inaccuracies, the data do indicate numerically, the important causes of blindness, and gives to us, as optometrists, an idea as to what we must do, to assist in the further reduction of loss of vision.

Table I

DEFINITE OCULAR PATHOLOGY CAUSING BLINDNESS

Blindness Caused by —	*Distribution of Cases by Per Cent*
CHOROID	
Choroiditis	0.2
CONJUNCTIVA	
Gonococcus conjunctivitis	0.1
Ophthalmia neonatorum	3.3
Trachoma	1.6
All other non-classified conjunctival disease	1.1
CORNEA	
Corneal opacities	0.1
Corneal ulcer	0.7
Keratitis	0.3
Staphyloma	0.1
CRYSTALLINE LENS	
Cataract	13.7
EYEBALL and ORBIT	
Neoplasms of eyeball	0.3
Neoplasms of orbit	0.3
Buphthalmos, etc.	0.1
IRIS	
Iritis	0.6
All other non-classified iris disease	0.1
MYOPIA	
Progressive myopia	0.3
OPTIC NERVE	
Optic atrophy	4.9
All other non-classified diesase of the optic nerve	2.0
RETINA	
Detachment of retina	0.5
Retinitis pigmentosa	0.1
Retinitis hemorrhagica	0.3
Retinitis, other	0.3
All other non-classified retinal disease	0.2
TENSION	
Glaucoma	5.4
AMAUROSIS (general)	
Disturbances of vision and diseases not included above	0.7
Combination of two or more ocular diseases	1.3
TOTAL DEFINITE OCULAR PATHOLOGY AS THE CAUSE OF BLINDNESS	38.6

Table II

GENERAL PATHOLOGY CAUSING BLINDNESS

Blindness Caused by —	*Distribution of Cases by Per Cent*
Brights' disease	0.2
Diabetes	0.3
Diphtheria	0.1
Diseases of head, not including meningitis	1.1
Influenza	0.8
Kidney diseases	0.4
Locomotor ataxia	0.2
Measles	2.2
Meningitis	1.5
Puerperal fever	0.2
Rheumatism	0.5
Scarlet fever	1.2
Skin eruptions	0.5
Smallpox	0.7
Spinal involvements	0.4
Syphilis	0.5
Typhoid fever	0.7
All other non-classified general diseases	3.7
Combination of two or more general diseases	0.6
General pathology for one eye, definite ocular pathology for the other	0.1
TOTAL GENERAL PATHOLOGY AS THE CAUSE OF BLINDNESS	15.9

Table III

INJURY OR ACCIDENT CAUSING BLINDNESS

Blindness Caused by —	*Distribution of Cases by Per Cent*
Animals	0.4
Blows to head	0.4
Burns	0.3
Cutting or piercing instruments	0.9
Explosives	3.0
Falls	1.2
Firearms	1.7
Foreign substances in eye	3.5
Machines	0.1
Operations (unsuccessful)	0.4
Poisoning	0.9
Accidental causes not definitely reported	6.3
TOTAL INJURY OR ACCIDENT AS THE CAUSE OF BLINDNESS	19.1

Table IV

INDEFINITE OR INACCURATELY REPORTED CAUSES OF BLINDNESS

Blindness Caused by —	*Distribution of Cases by Per Cent*
Catarrah	0.3
Colds	0.4
Congenital (cause not stated)	7.4
Electric light	0.1
Exposure to cold	0.1
Exposure to heat	1.4
Malaria	0.1
Malformation of eye	0.4
Medical malpractice	0.6
Menopause	0.3
Military service	0.6
Neuralgia	1.5
Old age	2.2
Paralysis	0.5
Scrofula	0.6
Sore eyes	1.4
Strained eyes	0.6
Wrong medicine or treatment	0.5
All other causes	6.5
TOTAL INDEFINITE OR INACCURATELY REPORTED CASES OF BLINDNESS	25.5
Blindness caused by a combination of causes in different classifications in Tables I, II, III and IV	0.9
TOTAL	26.4

These tables indicate that more than 54 per cent of all blindness is due to disease. If we take the inaccuracies listed in Table IV and classify these with Tables I and II, we find the total percentage of blindness due to disease, reaching a figure of approximately 70 per cent. Of the cases of blindness due to disease, we find that definite ocular pathology accounts for about 70 per cent of these, while general pathology is accounting for approximately 30 per cent. Of the total blindness reported upon, approximately 20 per cent is caused by injury or accident. The remaining causes of blindness are hereditary and congenital, and here, too, disease plays an important part.

It is therefore obvious that if we as optometrists are to assist materially in the development of a sound program for prevention of blindness, that we as ocular refractionists must devote more and more of our energies in the "screening-out-process" of those of our patients whom we find suffering from incipient or active ocular involvements, due either

to definite or specific ocular problems or due to general pathology. Additional time must be devoted in our refracting rooms to make the necessary diagnostic tests which make this pathologic screening, both possible and practical. Additional time, too, must be devoted each year in our graduate study activities, towards keeping abreast with the newer refinements which assist in making our diagnostic work both easier and more accurate.

Admitting the fact that the percentage figures given in Tables I, II and III are under-estimates, rather than over-estimates, of the causes of blindness, we find (Table I) that five definite ocular pathologic conditions are responsible for at least 30.9 per cent of all blindness in the United States. These five conditions are, ophthalmia neonatorum, 3.3 per cent; trachoma, 1.6 per cent; cataract, 13.7 per cent; involvements of the optic nerve, 6.9 per cent, and glaucoma, 5.4 per cent.

Of these, ophthalmia neonatorum does not concern the optometrist, being rather the problem (by law) of the obstetrician or the mid-wife. Trachoma, no longer on the increase in the United States, is apparent by the highly inflamed condition of the lids and the congested appearance of the anterior portion of the eye. Should a case of this highly infectious malady consult an optometrist, the patient with trachoma would be automatically and immediately referred to an ophthalmologist by the optometrist, whether or not a diagnosis was made by him.

Of the remaining ocular or general pathology, which may cause blindness, the problem is, from an optometrical standpoint, largely one of screening out those patients who are found to be suffering from an actual or incipient evidence of pathological degeneration. It is estimated that approximately 8 per cent[19] of the persons needing eye care have evidences of pathology; either specific ocular disease or the ocular results of degenerative abnormalities in other parts of the body. To be sure, not all of these 8 per cent, with evidence of pathology, are amenable to treatment. In fact, many do not require immediate attention, but all should be watched and kept under close observation. It is obvious, therefore, that the duty of the optometrist lies in detecting these changes from normal and in seeing to it that the case is kept under the care of a specialist who will, when the time is ripe for this, employ the proper measures to prevent the condition from advancing to that point wherein visual efficiency will be seriously impaired.

This is not an easy task nor one to be approached lightly. Many of the degenerative changes, particularly in the fundus, require adequate

knowledge of the subject and efficient techniques to enable the examiner to discover them. The job also requires a willingness on the part of the examiner to make the exhaustive and time-consuming tests necessary to make a proper diagnosis.

While all optometrists have been trained to do this work, it is necessary for practitioners to attend occasional "refresher" courses, in which the newer diagnostic techniques are presented and the various pathologic syndromes are reviewed. It is of interest to note that in recent years, additional emphasis is being placed upon these matters in our graduate courses of study, which will inevitably have a favorable bearing upon the work of blindness prevention.

From the clinical standpoint the optometrist is equipped to adequately perform this important work. With his case history; his corrected and uncorrected visual acuity findings; his external ocular inspection of the anterior portion of the eye; his analysis of the ocular reflexes; his ophthalmoscopic examination of the media and fundus; his visual field charting; his exhaustive study of the versions and the fusion sense; the diagnostic significance of sudden changes in refraction, as well as his ability to determine gross changes in intraocular tension, all enable him to differentiate the eye free from pathological deterioration from that affected by these changes.

As has been pointed out, either specific ocular pathology or the ocular results of general pathology is responsible for at least 70 per cent of all blindness in America today. In the preventive effort to reduce this total in future years, the optometrists of America can make a most serious contribution, by giving to this phase of their work, the additional attention which will make their work of greater value to society, and which will do much towards adding greater refinement in the ocular screening process of those patients to whom medical or surgical care would be beneficial.

Carel C. Koch.

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SPECIAL REPORTS

REPORT OF THE AMERICAN ACADEMY OF OPTOMETRY COMMITTEE ON NOMENCLATURE AND STANDARDS*

Glenn A. Fry, Chairman,
Frank K. Moss, Sterrett S. Titus, and Richard M. Hall.

PART I—INTRODUCTION

After considering various methods which might be used in arriving at a unified system of nomenclature and standards, the Committee decided on the following program:

(1) Development of an authentic history of the concepts relating to accommodation and convergence.

(2) Formulation of philological definitions[1] of terms which have been used for describing accommodation and convergence.

(3) Formulation of a set of standards for quantitative specification of accommodative and convergence phenomena.

(4) Formulation of a unified system of nomenclature for describing accommodative and convergence phenomena.

In order to carry forward with the work of the Committee the

*An abridgment of a Committee Report presented by the chairman before the American Academy of Optometry.

[1] In order to present a concrete conception of a philological definition, the following remarks may be added which are based on the article pertaining to dictionaries in the Encyclopedia Brittanica. According to this article, the early lexicographers were expected to register words deemed good for literary use, with their *proper* meanings. The first effective protest in England against this method was presented to the Philological Society in 1857 in a paper by Trent entitled, "Some Deficiencies in Existing English Dictionaries." He said, "A dictionary according to that idea of it which seems to me alone capable of being logically maintained, is an *inventory of the language;* much more, but this primarily. . . . It is no task of the maker of it to select the *good* words of the language. . . . The business which he has undertaken is to collect and arrange all words, good or bad, whether they commend themselves to his judgment or otherwise. . . . *He is a historian* (of the language), not a critic."

Recommendations made by Trent resulted in the development of the Oxford New English Dictionary, which exemplifies the principle of modern scientific philology that a dictionary must be a historical record of words. The philologist desires "to know when and where each word, and each form and sense of it, are first found in the language; if the word or sense is obsolete, when it died; and any other fact that throws light upon its history and implication."

chairman has developed an outline history of the development of concepts relating to accommodation and motility of the eyes. This outline history should be greatly enlarged and enriched by references and quotations, and actual reproduction of rare, valuable documents. Various members of the Academy might contribute to this work by translating and abstracting articles written in foreign languages. In order to assimilate and coordinate material collected in this way, it is recommended that the Council consider creating a Fellowship for a man who would be willing to devote ample time to this task. This work ought to be under the supervision of the Academy's Committee on Nomenclature and Standards.

The development of a history of concepts relating to accommodation and convergence will be of value in two respects.

(1) It will help to cultivate an appreciation of the need for a set of standards and a unified system of nomenclature.

(2) It will help in the formulation of philological definitions, by fixing the beginning date beyond which it will not be necessary to trace the use of words, and by indicating the samples of literature which will have to be searched for words and uses of words.

The Committee has not commenced formulating a list of philological definitions, but recommends that this task be undertaken by the same research fellow who is assigned to the task of developing a history of concepts relating to accommodation and convergence.

If the philological method were properly used in working out a system of definitions applicable to accommodative and convergence phenomena, these definitions could in no way prove objectionable to anyone. Once such a system of definitions could be worked out, the members of the Academy would be in a position to judge whether a recommended unified system of nomenclature involves the least possible amount of distortion of the current use of words and their etymological significance.

Owing to the urgent need for a system of quantitative specification of accommodative and convergence phenomena, the Committee has found it wise to attempt to formulate immediately a set of standards. The reference points and planes chosen for this system are arbitrary and represent a compromise of various standards now in use.

The set of standards presented in subsequent parts of this report

is to be regarded as tentative, and it is recommended that no action be taken until the Committee has had time to incorporate suggestions which might be offered by various members of the Academy, and to supplement the set of standards with adequate historical references.

PART II—QUANTITATIVE SPECIFICATION OF DATA RELATING TO THE DIRECTION OF THE LINE OF SIGHT

The Entrance Pupil. The entrance pupil of the eye is the virtual image of the real pupil formed by refraction at the cornea. It represents what is actually seen when one person looks at another's pupil. It is, therefore, directly observable and can be experimentally located. For practical purposes it is satisfactory to assume that it is located 3 mm. behind the front surface of the cornea.

The Point of Fixation. When a person has one eye occluded and is instructed to look with his other eye directly at a given point and makes an effort to do so, the eye is brought into a definite position with relation to the point. This phenomenon depends upon the fact that the eye turns so that the image of the point looked at is projected on some minute part of the retina, which usually lies within the fovea, and which remains constant in repeated attempts at fixation. The point looked at is called the point of fixation.

The Line of Sight. The line connecting the point of fixation and the center of the entrance pupil is known as the line of sight. The significance of this name consists in this, that if a person tries to line up his eye with two points, one of which serves as the point of fixation, what he does is to get the two points in line with the center of the entrance pupil. If the eye is in focus for the point of fixation, the blur circle produced by the other point is concentric with respect to the point image of the point of fixation.

The Center of Rotation. It is possible to determine experimentally one point within the orbit, through which it can be assumed that the line of sight must pass regardless of the direction in which it is oriented. This point can be designated as the center of rotation. It can be assumed to lie on the line of sight 13 mm. behind the cornea when the eye is in its straight forward position.

A System of Coordinates for Specifying the Direction of the Line of Sight. For purposes of visual testing, the erect position of the head can be defined as one in which the line connecting the two centers of

rotation is horizontal, and the plane touching the chin and the two superciliary ridges are vertical.

The primary horizontal plane can be defined as the one passing through the two centers of rotation when the head is in an erect position.

The line connecting the two centers of rotation can be called the base line.

The line in the primary horizontal plane which is perpendicular to the base line at its midpoint can be designated as the sagittal line.

Either line of sight can be said to be in its straight forward (antero-posterior) position when it is parallel to the sagittal line.

The distance between the two centers of rotation can be assumed to be equal to the distance between the centers of the two entrance pupils when the lines of sight are straight forward.

Changes in the direction of fixation can be specified in terms of rotation of the eye around vertical and horizontal axes.

The vertical axis for each eye is fixed with respect to the head and passes through the center of rotation perpendicular to the horizontal plane of the head. The horizontal axis for each eye is perpendicular to the vertical axis and rotates around it. A rotation of the horizontal axis around the vertical axis is known as an azimuthal rotation. The line of sight is perpendicular to the horizontal axis, and rotates around it. An inclination of the line of sight above or below the horizontal plane of the head is known as an elevational or depressional rotation of the eye.

This system of coordinates is particularly useful for specifying the primary position of an eye with respect to the head, and for specifying the various degrees of false torsion associated with different directions of fixation.

Specification of Convergence for Points on the Sagittal Line. Since most visual tests are made with targets at various points on the sagittal line, special consideration must be given to the specification of convergence for these points.

One method often used is that of specifying the amount of convergence in terms of meter angles. According to this concept the angle

formed by either line of sight with the sagittal line at the point of fixation is called the angle of convergence. The angle which one line of sight forms with the sagittal line is equal to the angle formed by the other line of sight with the sagittal line.

$$\text{The size of the angle of convergence expressed in meter angles} = \frac{\text{Sine of the angle of convergence}}{\text{.5 (Interpupillary distance expressed in meters.)}}$$

This particular method of specifying the stimulus of convergence is satisfactory so long as the stimulus to convergence is varied by changing the distance of the object, but it is not convenient for specifying changes in convergence induced by prisms or by manipulation of a reflecting phorometer. It cannot be used for asymmetrical convergence. It is recommended therefore that in all cases the amount of convergence should be specified in terms of the centrad which is universally applicable, and that the use of the meter angle be discontinued. A centrad is equal to 0.57 degrees or .01 radians.

It is recommended that the angle of convergence be defined as the angle subtended by the two lines of sight at their intersection. When they intersect at a point behind the eyes, the angle can be called an angle of divergence or negative convergence. It should be noted that this angle is equal to the deviation of the two lines of sight from parallelism, and hence the concepts of convergence and deviation from parallelism are identical.

In cases of symmetrical convergence the angle of convergence expressed in degrees can be computed in accordance with the following formula:

$$\text{Tan } \tfrac{1}{2} \text{ angle of convergence} = \frac{\tfrac{1}{2} \text{ Interpupillary distance in meters}}{\text{Distance in meters from the point of convergence to the spectacle plane} + .027 \text{ M.}}$$

In this formula .027 M. represents the distance from the spectacle plane to the base line connecting the two centers of rotation. The division of the distance from the point of convergence to the base line is necessary because distances on reading rods attached to trial frames and phoropters should be calibrated with reference to the spectacle plane in order to simplify the specification of stimuli to accommodation. Once the con-

vergence is computed in degrees, it can be converted to centrads by the following formula:

Convergence in centrads = 1.745 convergence in degrees.

The power of prisms used for inducing changes in convergence should be specified in terms of centrads instead of prism diopters. This is necessary in order to determine the sum or difference of two rotations. For example, it is necessary to determine the sum of the base in and base out to break findings in order to compute the prism range of fusion. In making this computation it is not satisfactory to say that $10\triangle + 10\triangle$ is equal to $20\triangle$ but it would be satisfactory to say that $10\triangledown + 10\triangledown$ is equal to $20\triangledown$.

In order to change over from the use of prism diopters to centrads, it would not be necessary for prisms now in use to be recalibrated, because for purposes of visual testing the prism diopter can be regarded as equivalent to a centrad. Up to $20\triangledown$ the discrepancy is less than $.5\triangledown$

Prism Prescriptions. In writing a prescription for a prism the power of the prism should be specified in terms of centrads. As convenience permits, specifications for grinding prisms should be modified to give centrad values exactly, and also the devices for measuring prism power should be recalibrated.

The methods of decentering lenses to obtain prism effects would not have to be changed because the formula: Deviation in prism diopters = (Decentration in cm.) (Power in diopters) is only an approximation and the following formula is more correct: Deviation in centrads = (Decentration in cm.) (Power in diopters.)

Specification of Convergence for Points above or below the Horizontal Plane of the Head. The plane passing through the two centers of rotation and the point of fixation can be designated as the plane of fixation. The elevation or depression of this plane above or below the horizontal plane of the head can be specified in degrees.

For the purpose of specifying the amount of convergence it must be assumed that the vertical axis of each eye is perpendicular to the plane of fixation. The horizontal axis of each eye is perpendicular to the vertical axis and rotates around it. When convergence is specified in terms of this system of coordinates, the specification is the same for all degrees of elevation of the plane of fixation.

Specification of Asymmetrical Convergence. The median line can be defined as the line connecting the point of fixation and the middle of the base line between the two centers of rotation. Convergence is defined as symmetrical when the median line is perpendicular to the base line. The degree of asymmetry can be described in terms of the deviation of the median line from its perpendicular position.

Specification of Vertical Divergence. The same system of coordinates can be used for specifying vertical divergence. In vertical divergence the two lines of sight cannot cross at a common point, so it is necessary to designate one eye as the fixing eye, and the plane passing through the base line and the line of sight of the fixing eye as the plane of fixation. Vertical divergence can then be designated as the angular elevation or depression of the line of sight of the non-fixing eye above or below the plane of fixation.

The convergence of the two lines of sight in vertical divergence can be expressed in terms of the angle formed by the intersection of the planes through the lines of sight which are perpendicular to the plane of fixation.

PART III. QUANTITATIVE SPECIFICATION OF DATA RELATING TO THE ACCOMMODATION OF THE EYE

Specification of the Refractive State of the Eye. The refracting mechanism of the eye possesses the remarkable ability of accommodating itself for different distances; that is to say, the eye can focus on the retina a clear image of an object at one distance at one moment and an object at another distance a moment later. The process of accommodation is a change in the refractive state of the eye.

Of all the variable phenomena associated with accommodation the only one which can be easily measured is the change in the position of the point for which the eye is accommodated. One can therefore specify the refractive state of the eye at a given moment by stating the position of the point for which the eye is accommodated (that is, by stating the distance from the cornea or some other point associated with the eye), but changes in the position of this point do not give as satisfactory a unit for measuring changes in the refractive state of the eye as that provided by the concept of refraction of the eye.

Refraction of the eye is a name given to the value of the reciprocal of the distance on the line of sight from the point of clear vision to the spectacle point (14 mm. in front of the cornea). When the distance is

given in meters, the expression for refraction is in terms of diopters.

Changes in Accommodation. Changes in accommodation can be described in terms of the changes in refraction of the eye, the diopter being the unit.

When the eye is astigmatic, that is, when it cannot focus for the same point in all meridians, it is necessary to give separate values for the refractive states in the two principal meridians.

The Zero Level of Accommodation. It is difficult to arrive at a satisfactory definition of the zero level of accommodation in terms of a state of repose of the ciliary muscle owing to the general disagreement as to what constitutes an adequate set of conditions for inducing a state of repose. It is necessary therefore to choose arbitrarily some level which can be used as a zero level for specifying various amounts of accommodation.

It is proposed therefore to regard as the zero level of accommodation that refractive state of the eye in which it is focused on an infinitely distant object while looking through its distance correction. So far as the specification of accommodation is concerned, it is of no consequence whether this or that distance correction is justified by the empirical findings. The whole system of specification of accommodation must be relative to the specification of the distance correction.

The Stimulus to Accommodation. The stimulus to accommodation may consist of a real object, or an image seen through a combination of lenses, mirrors or prisms. The stimulus must be specified as lying on the line of sight.

In specifying the stimulus to accommodation it simplifies the procedure if a lens or combination of lenses is worn before the eye which corrects the errors of refraction and which can be regarded as equivalent to a simple thin lens placed 27 mm. in front of the center of rotation. When a correction for the error of refraction is worn without any additional lenses, stimuli to accommodation can be specified in terms of the reciprocal of the distance from the target to a point on the line of sight 27 mm. in front of the center of rotation.

The stimulus to accommodation can be increased by adding a minus spherical lens to the distance correction. As long as the minus lens can be regarded as equivalent to a thin lens placed 27 mm. in front of the center of rotation, it may be assumed that the increase in stimulation to

accommodation is equivalent to the numerical value of the power of the lens. The same proposition applies to decreasing the stimulus to accommodation by adding a plus lens.

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TRANSACTIONS OF THE AMERICAN ACADEMY OF OPTOMETRY

by J. Fred Andreae, Secretary

A department devoted to announcements, reports, appointments, organization data, news, professional problems and ideals, as these relate to the Academy.

ON THE VALUE OF FELLOWSHIP IN THE ACADEMY

Letters crossing the Secretary's desk ask the question, "What has the Academy to offer a member who is unable to attend the Annual Meetings?"

To my mind, this is a pertinent, reasonable question deserving consideration and response. While the Annual Meeting offers opportunity for fraternization, attendance at lectures, and participation in the discussions following the delivery of papers, these are but a small part of the benefits accruing to one honored with Academy Fellowship.

Academy Fellowship is a distinct privilege, accorded only after a thorough screening covering the ability, capability, and eligibility of the optometrist seeking membership. All of the foregoing is covered in the Manual of Instruction and application for membership.[1] Once the optometric profession is appraised of Academy membership requirements and the definite rule that these requirements can never be violated, Academy Fellowship takes on a new meaning and becomes all the more desirable and envied.

Past events have proved that the American Academy of Optometry stands as the spokesman for ethical, professional optometry. This is no idle boast, and the leaders in Academy affairs know that, were all practicing optometrists Fellows of the Academy, many of optometry's ills would vanish overnight. It is for this reason that all eligible optometrists are urged to qualify for Fellowship. Courteous attention will be

[1]Pages 247 and 248.

paid to all inquiries and, in borderline cases, help will be given to make qualification possible.

Those in charge of the Academy serve without compensation and give freely of their time and services, but they feel many times repaid in the progress the Academy is making in its effort to bring optometry to its rightful place among the accepted professions.

Commenting further on the question inciting this article: The mere fact that attendance at the Annual Meeting is impossible should be no deterrent to becoming or continuing as a Fellow. An appreciation of Academy ideals, the potentialities for professional recognition and advancement, and the opportunity offered the individual optometrist to bring same to a realization, bring one face to face with the fact that it is not a question of what the Academy might offer the individual, but of *what the individual can give to the Academy and, through it, to his profession.*

It is my opinion that the profession of optometry will not be accorded universal recognition until such time as all optometrists meet the standards adopted by the American Academy. This is absolutely no reflection on any individual who practices according to his light, but it is a simple statement of fact. Academy requirements, boiled down, mean simply that an optometrist MUST practice in the same manner and environment as does his local ETHICAL dentist and physician.

DATE CHANGED FOR ACADEMY BREAKFAST AT ATLANTIC CITY

The date for the breakfast of Fellows of the American Academy of Optometry, in attendance at the annual congress of the American Optometric Association at Atlantic City, has been changed to Tuesday, July 1st. This Academy Breakfast will be held at the Ambassador Hotel. Advance registration indicates that a large number of Fellows will be in attendance.

The Academy Executive Council has scheduled a meeting during this optometric congress week and will consider matters dealing with local chapters.

It has also been suggested that optometrists who contemplate making application for Academy Fellowship, do so at an early date to assure

action on their applications before the regular annual meeting of the Academy at Chicago.

Members of the Academy who will attend the congress at Atlantic City are urged to make their hotel reservations at the Ambassador Hotel as early as possible as already more than 500 optometrists' reservations are on file.

ABSTRACTS

A department in which will appear abstracts of the literature of optometry, ophthalmology and applied optics. These will be classified according to the following list, although contributions to all sections will not necessarily appear in each issue.

1. Ocular Refraction.
2. Physiological Optics and Color Vision.
3. Ocular Muscles.
4. Orthoptics and Reading.
5. Anatomy, Histology and Embryology.
6. Ocular and General Pathology.
7. Ophthalmic Lenses and Material.
8. Instruments.
9. Hygiene and Illumination.
10. Applied and Physical Optics.
11. Education, Sociology and Economics.
12. Miscellaneous.

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1. OCULAR REFRACTION.

THE VISUAL FACTOR. Special Report. Journal of New Jersey Optometric Association, 1941, 12, 1, 4-5.

Industrial visual efficiency can only be determined by a refraction in which at least the following tests are made. (1) Case history. (2) External examination of lids, the external eye and appendages. (3) Ophthalmoscopic examination of the media, fundus, optic nerve and vessels. (4) Ophthalmometer investigation of the cornea. (5) Objective and subjective refraction. (6) Tests of the extra-ocular muscles. (7) Accommodative near-point tests. (8) Fusion tests for stereopsis. (9) Glare tests to determine light and dark adaptation, and (10) an investigation of the visual fields. C. C. K.

SUBJECTIVE TESTING. Coates, W. R., South African Optometrist (Johannesburg), 5, 3, 73-76.

Four distinct methods of subjective eye testing are described by Coates, who finds these refractive techniques of particular value in the determination of the axis of the correcting cylinder. Various revolving astigmatic charts are also presented. C. C. K.

THE EXAMINATION AND REFRACTION OF CHILDREN. Gunton, B., Refractionist (London), 1940, 29, 511, 161-164.

Very young pre-school children are brought to optometrists for examination and visual care, for the greater part, for two reasons: (1) strabismus, and (2) as a visual precautionary measure. Gunton reviews the refractive techniques suitable for use in examining these young people as well as children in the lower grades. He suggests that this work affords a proper field of optometrical specialization. C. C. K.

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2. PHYSIOLOGICAL OPTICS AND COLOR VISION.

WHAT SUBLUXATED LENSES REVEAL ABOUT THE MECHANISM OF ACCOMMODATION. Luedde, W. H., American Journal of Ophthalmology, 1941, 24, 40-45.

Luedde maintains that accommodative changes in the form or position of the crystalline lens are the "result of extrinsic forces actively applied." These forces consist essentially of a concentric impact of the periphery of the vitreous against the zonule and posterior surface of the equatorial zone of the lens when the ciliary muscle contracts. Eyes with subluxated lenses show the lens to wobble when accommodation is not exerted. This wobbling ceases during active accommodation. When maximum accommodative effort is reached, a noticeable trembling occurs "somewhat like a large bead attached to a mass of jelly." The evidence of tension on the zonule and the effect of accommodation upon the iridodonesis repudiates Helmholtz's hypothesis of the mechanism of accommodation which assumes relaxation of the zonule and elasticity of the lens substance. R. J. B.

THE NERVE MESSAGES IN THE FIBERS OF THE VISUAL PATHWAY. Hartline, H. K., Journal of the Optical Society of America, 1940, 30, 239-247.

Present-day methods make it possible to detect and record the activity produced in the fibers of the optic nerve in response to illumination of the eye. Thus the signals which are sent by the photoreceptor cells to the nerve centers may be intercepted, and, since it is possible to register the responses in single nerve fibers, the activity of the individual cellular units under different conditions may be investigated. In addition to providing information regarding the actual sensory data that are supplied to the visual centers of the nervous system, this method

makes possible an objective study of the mechanisms whereby the visual sense cell translates light into nervous activity. The disturbance which is set up in a nerve fiber when it is stimulated, and which spreads as a wave from the point of stimulation, consists of an alteration in the molecular structure of the living tissue—an active response of each element of length of the fiber. Chemical reactions take place, and physical changes can be detected in the fiber as this wave of activity is propagated along its length. One of the physical accompaniments of this alteration in structure is a change in the electric potential of the point which is actively responding, measured with respect to an adjacent, as yet inactive, point on the fiber. It is the commonly accepted view that the local electric currents resulting from this difference in potential are directly responsible for the excitation of the region of the nerve fiber just ahead of the advancing wave front of the propagated disturbance. The fluctuation in the potential of a given point on the nerve fiber, due to the passage of such a propagated disturbance, can be recorded by any device capable of registering small, rapid voltage fluctuations. By this method the activity in the fibers of the optic nerve has been studied. The experiments reviewed in this paper illustrate the analysis of visual function by direct experimental studies of the activity of individual cellular units. They show how familiar phenomena of vision may be traced to properties of the receptor cells, based on their physical and chemical constitution. As one proceeds from the receptor cells to the higher nerve cells of the visual pathway, new problems arise due to the interaction between the individual units; these experiments indicate how general principles of nervous action may be applied toward a solution of these difficult problems. They emphasize especially the necessity for considering patterns of activity in the nervous system. Individual cellular units never act independently; it is the integrated action of all the units of the visual system that gives rise to vision. R. J. B.

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3. OCULAR MUSCLES.

PARALYSIS OF CONVERGENCE. Roper, K. L., Archives of Ophthalmology, 1941, 25, 336-353.

Roper introduces this case report with an historical survey illustrating the differences of opinion which have existed concerning convergence paralysis and its etiology. The anatomy, physiology and pathogenesis of the condition is then reviewed. The case presented is that of a white boy, age thirteen, whose complaint was diplopia of near objects, of two months' duration. Two months prior to examination, according to the

mother, the boy had been ill with the "grip" and had been confined to bed for two weeks, during which time he had a temperature of 101° F. Examination revealed diplopia for near vision and an inability to converge which have remained constant. Both the internist and neurologist consulted concur in the opinion that encephalitis was likely the causative factor in view of the history of the acute illness of two weeks' duration preceding the onset of diplopia. Roper concludes that "convergence paralysis is a rare condition in which the paralysis remains permanently. The variety of theories and opinions concerning this anomaly clearly indicate the need of a better understanding of the anatomy and pathogenesis involved." R. J. B.

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4. ORTHOPTICS AND READING.

RIGHT-EYED PEOPLE BEST READERS. Crosland, H. R., Iowa Optometrist, 1941, 19, 1, 6.

Crosland conducted tests of reading speed and found those subjects whose dominant eye was the right eye to be the fastest readers. C. C. K.

READINESS TO READ. Littlefield, R. E., Mid-West Optometric Journal, 1940, 7, 12, 14-15.

Littlefield claims that no remedial reading training program can possibly succeed in cases in which the refractive and ocular innervational problems of the patient are either unsolved or but partially solved. C. C. K.

ABUSE IN THE SPEED-OF-READING FAD. Pascal, J. I., Western Optical World, 1940, 28, 10, 407-408.

Pascal criticizes speed-of-reading tests and training programs, pointing out that the "speed-of-understanding" what has already been read, is of far greater importance than the mere ability to rapidly read printed material. C. C. K.

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6. OCULAR AND GENERAL PATHOLOGY.

CATARACT IN DIABETES. Wolfe, O., Journal of the American Optometric Association, 1940, 9, 12, 353-355.

Wolfe believes that diabetic cataracts are caused by a nutritional disturbance of the crystalline lens metabolism. He finds this type of lens

involvement the most common of the cataracts caused by general disease. The paper presents three complete case reports in which vision was restored to useful levels. One of these reported cases was of a child five years of age. C. C. K.

SPHYGMOMANOMETER IN OPTOMETRIC PRACTICE. Bark, C. A., Pennsylvania Optometrist, 1940, April, page 6-7.

The author suggests that all refractive patients with the symptom of dizziness should have their blood pressure taken as part of the routine eye examination. C. C. K.

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7. OPHTHALMIC LENSES AND MATERIAL.

THE PSYCHOLOGY OF FITTING CONTACT LENSES. Anderson, E., Canadian Optometrist, 1941, 2, 10, 304-305.

Anderson reviews the natural inhibitions which have to be overcome on the part of the patient when undergoing the initial fitting of a contact lens. The patient's worry over the possibility of pain; the obvious apprehension at the first insertion of the lens, and the fear of possible difficulty which may be encountered on its removal, are all covered in this report. The author also reviews the conduct of the optometrist at this critical period in the fitting of the contact lens. C. C. K.

ABSENCE OF DRUGS IN FITTING CONTACT LENSES. Feinbloom, W., Optometric Weekly, 1941, 31, 52, 1465-1466.

New larger plastic contact lenses make possible the fitting of these aids to sub-normal vision, without the use of an anaesthesia. The new trial series of plastic contact lenses consisting of combinations of contact lenses with a scleral radii varying from 12 mm. to 14.8 mm. in steps of 0.2 mm. make possible, according to Feinbloom, the insertion and use of these sub-normal visual aids without resorting to the use of anaesthetics. C. C. K.

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9. HYGIENE AND ILLUMINATION.

THE READABILITY OF STENCIL-DUPLICATED MATERIALS. Luckiesh, M., and Moss, F. K. Sight-Saving Review. 9, 4, 295-304.

The authors find that as visibility of reading matter increases, the subject's tenseness and rate of blinking decreases. A study is made of the readability of stencil-duplicated material. These stencil copies were found to grade into two classes, the superior and average grade as to their qual-

ity of readability. According to the authors, the average stencil duplicated material has only 70 per cent of the readability of the superior quality. C.C.K.

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11. EDUCATION, SOCIOLOGY AND ECONOMICS.

BUILDING A PROFESSIONAL PRACTICE. Farmer, W. S., Kentucky Optometrist, 1941, 14, 11, 6-7.

For the general betterment of the profession, professional practitioners of optometry should become more active in service club programs, participation in civic city-wide undertakings, sports, and privately supported charitable undertakings. Farmer urges that more mention be made of these matters in the optometry schools. C.C.K.

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12. MISCELLANEOUS.

THE EFFECT OF ALCOHOL ON DRIVING SKILL. Newman, H., and Fletcher, E., Journal of the American Medical Association. 1940, 115, 19, 1600-1602.

Sixty-five subjects were used in a series of performance tests for speed of reaction in steering and braking a motor car. On the first day each subject was given a trial period, to become familiar with the routine of the test. On the following day each subject received a dose of alcohol administered in the form of commercial whisky diluted to taste with carbonated water. The average amount given each subject was 1 cc. per kilogram of subject's weight. The second reaction test was given 15 minutes following the imbibing of the alcohol. The authors conclude that (1) the consumption of alcohol adversely affects driving ability, and (2) that performance in the test of simple steering of a motor car is a better criterion of intoxication than is the blood alcohol concentration test suggested by the National Safety Council. C.C.K.

OPTOMETRISTS IN THE NAVY. Dicus, M. L., Journal of the New York State Optometric Association. 1941, 8, 7, 127-128.

Dicus reviews the optometrical professional qualifications and educational requirements necessary for optometrists to secure a commission as a reserve officer in the United States Navy. Qualified optometrists may be assigned to the following ranks, Ensign, Lieutenant Junior Grade, and Lieutenant. C.C.K.

Current Comments by Carel C. Koch

A Monthly Department

in which the Editor of the AMERICAN JOURNAL OF OPTOMETRY & ARCHIVES OF THE AMERICAN ACADEMY OF OPTOMETRY will discuss items of news of general interest; such as relate to new instruments, clinical techniques, education, public health, and optometric legislative and organization problems.

SHORT OPTOMETRIC GRADUATE COURSE

The twelfth annual practitioners clinical and educational week of the Pennsylvania State College of Optometry will be held at the college in Philadelphia, week of June 22-27. An attractive and practical program will be presented to graduate optometrists during this week. Optometrists may enroll in one or more of a number of specialized short courses. As the attendance in each course is limited, optometrists who plan to attend are requested to communicate at once with the college.

ANNUAL MEETING OF BETA SIGMA KAPPA

The International Fraternity, Beta Sigma Kappa will hold its annual meeting during the Congress of the American Optometric Association at Atlantic City, New Jersey. This annual fraternity meeting will start with a dinner at 6:30 P. M. on July 1st. The meeting will take place at the Ambassador Hotel. Dr. Harry Pine of Chicago, International President, will preside. Members of Beta Sigma Kappa are urged to make early reservations.

READING PROGRAM FORUM ON OPTOMETRY AND EDUCATION

The common problems of education and optometry will be discussed at a forum to be held on Sunday, June 29, the opening day of the annual congress of the American Optometric Association at Atlantic City, New Jersey. This forum will be held at the Ambassador Hotel and will be attended by optometrists as well as educators from all eastern states. The following speakers will present papers.

Dr. Earl H. Ridgeway, Chief Optometric Consultant, New Jersey Optometric Research Clinic, "Important Considerations in the Development of a Modern Reading program."

Dr. Emmett T. Betts, Research Professor and Director of the Reading Clinics, Penn State College, "Developmental Deficiencies and Reading Difficulties."

Mr. Thomas J. Durell, Assistant Commissioner of Education in Charge of Elementary Schools, "Teaching Reading in the Elementary Schools."

Dr. Ernest C. Witham, Associate Professor of Education, Rutgers University, "The Physical Eye and the Mind's Eye."

Dr. Harry C. Hill, Supervisor of Schools, Mercer County, N. J., "A Program of Cooperation in Remedial Reading."

Miss Olive Williams, Teaching Principal, Green Avenue Schools, Madison, N. J., "The Comics—Their Appeal and Their Perils."

Dr. Mildred G. Moss, Educational Consultant, Child Clinic, Trenton, N. J., "The Significance of Eye Readiness in a Reading Readiness Program."

Miss Althea H. Nichols, Teacher of Braille and Sight-Saving Class, Montclaire, N. J., "Visual Deficiencies as a Problem in Reading."

All optometrists and delegates to the American Optometric Association Congress are invited to attend this important forum dealing with the common visual problems of education and optometry.

OPTOMETRIC SPEAKERS AT THE A.O.A. CONGRESS

The following optometrists will present technical papers at the 44th annual congress of the American Optometric Association, to be held at the Ambassador Hotel at Atlantic City, New Jersey, week of June 29, 1941.

Dr. William Policoff, Wilkes-Barre, Penna. "Sub-Normal Vision."
Dr. F. W. Brock, Staten Island, New York City. "Orthoptics."
Dr. Leo F. Madigan, Dartmouth Eye Institute, Hanover, N. H. "Aniseikonia."

All delegates and optometrists attending this congress are invited to be present at these educational sessions which will be held on Tuesday, July 1, 1941.

A FORUM ON THE CONSERVATION OF VISION OF INDUSTRIAL WORKERS

A forum planned to bring together leaders in optometry, industrial lighting, personnel management and safety engineering has been arranged for Thursday, July 3, 1941, during the annual congress of the American Optometric Association at Atlantic City, New Jersey. The forum will be held at the Ambassador Hotel and all optometrists attending the congress are invited to attend. The following speakers will present papers.

Mr. Vern A. Zimmer, Director, Division of Labor Standards, U. S. Department of Labor, "Conservation of Manpower in Defense Industry."

Mr. Harry Guilbert, Director, Bureau of Safety and Compensation, The Pullman Company, "Prevention of Eye Injuries in Industry."

Mr. A. A. Hendrix, Assistant Personnel Director, Ternstedt Division, General Motors Corporation, "The Problem of Employing Eyes."

Mr. S. G. Hibben, Director, Applied Lighting, Westinghouse Electric and Manufacturing Company, "Lighting—Old and New."

Mr. H. L. Logan, Managing Engineer, Controlens Division, Holophane Company, Inc., "Applications of Modern Lighting in Industry."

Drs. Matthew Luckiesh and Frank K. Moss, Director and Physicist, Lighting Research Laboratory, General Electric Company, "Light, Vision and Seeing in Industry."

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CLASS II.—Open to any optometrist who has been in practice more than five years but less than fifteen, and who is now practicing in an ethical and professional manner* and upon acceptance by the Board of Examiners of five case reports from his own files concisely and completely annotated as outlined in the Manual of Instruction, and who has taken and successfully passed a practical examination. It is to be understood that the examination given by the Board is in no way comparable to individual State Board Examinations, but is in the true sense, a screening process by which the Board of Examiners will be able to determine the ability of the candidate to successfully handle the practical problems met in general routine practice.

CLASS III.—Open to any optometrist who has been in practice less than five years, and who is now practicing in the prescribed manner* and upon acceptance by the Board of Examiners of three case reports from his own files concisely and completely annotated as outlined in the Manual of Instruction, and who has taken and successfully passed both the written and clinical examinations as outlined in the Manual.

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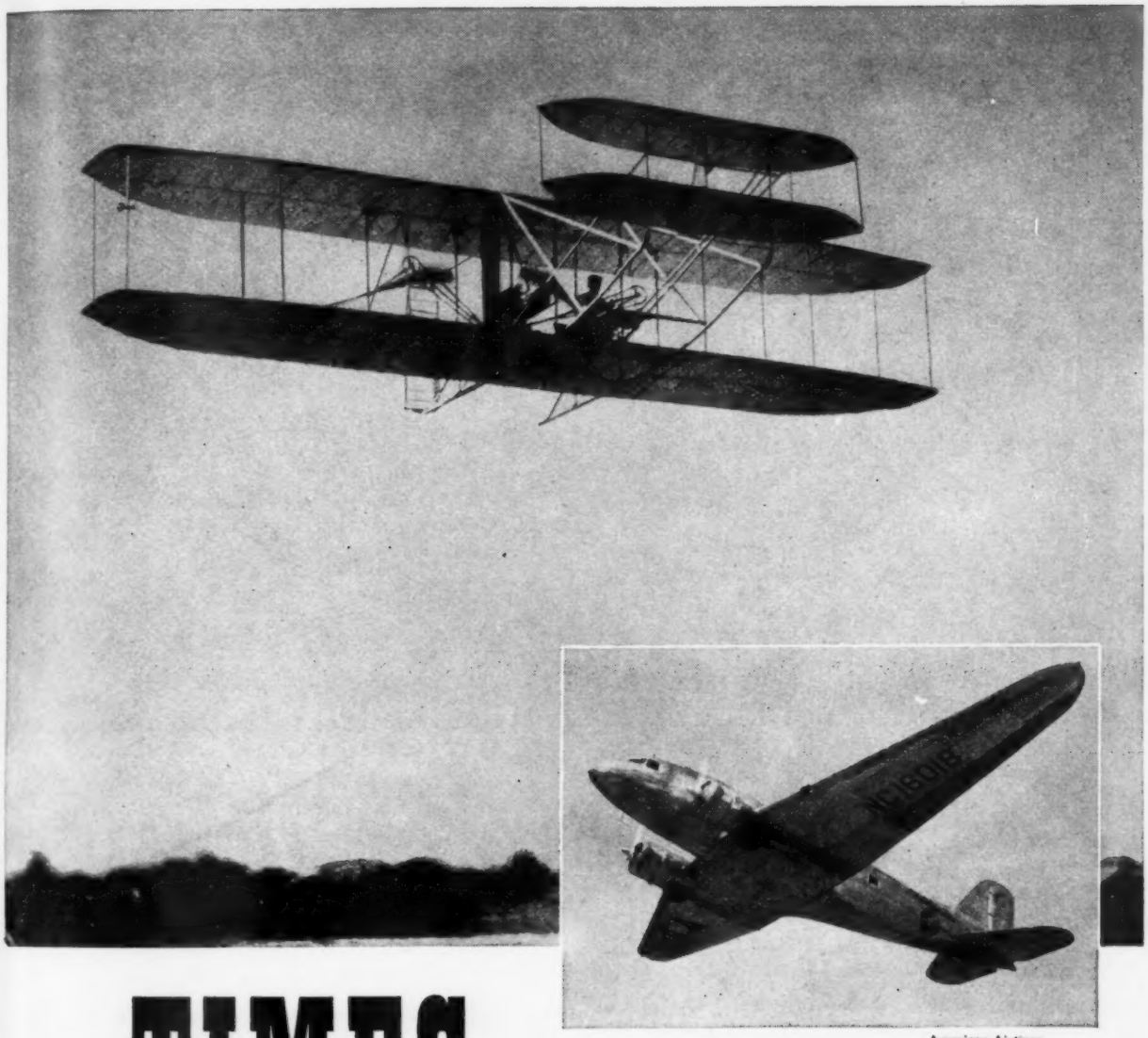

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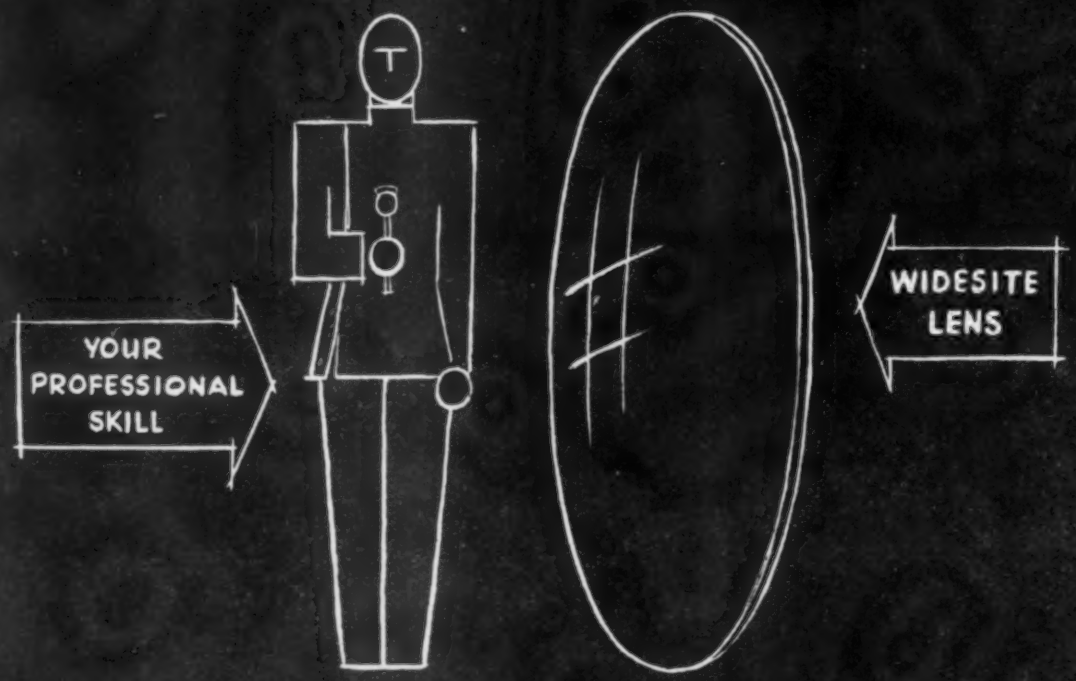

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